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To: All State Directors
Attn: State Engineers

From: Director, National Science and Technology Center

Subject: Corrosion Resistant Steels

The 2000 Annual Meeting of the AASHTO's Subcommittee on Bridges and Structures was held in Charleston, South Carolina, during the week of June 4, 2000. During these annual meetings formal presentations of studies and research are typically given by technical experts such as college professors, research and development specialists, state highway personnel, industry representatives, and federal officials. During this year's meeting, Dr. Gareth Thomas, Vice President of Research and Development at MMFX Steel Corporation of America, Newport Beach, California, presented an overview of the process he has developed to produce radically different steels that are highly corrosion resistant.

Presently, steel corrosion is addressed by either treating the materials with coatings such as paint, epoxy, galvanization, metal plating or finishes, or by the substitution of expensive alloy steels such as stainless steel. Epoxy-coated reinforcing steel is the primary method of protecting concrete reinforcement from corrosion. However, epoxy coatings are susceptible to material handling damage, which in some cases has actually accelerated the corrosion process. Epoxy coatings are also expensive and can add 50-60 percent to the cost of the reinforcement.

The newly developed steels achieve their exceptional corrosion resistance as a result of the microstructure of the steel that is formed during the new production process. This new patented process, which alters the steel microstructure, minimizes the formation of microgalvanic cells. Microgalvanic cells initiate corrosion through the electrochemical reaction of two dissimilar metallic elements in the presence of an electrolyte (e.g., sodium chloride solution) and an electron conductive path. In the lamellar microstructure of conventional steel, a continuous galvanic path is formed between ferrite and carbide cells and corrosion can easily be initiated. The newly

patented process transforms the lamellar ferrite-carbide microstructure into one of ferrite-martensite. Martensite has a needle-like crystalline structure that is produced as a result of the rapid cooling of the steel through a controlled quenching process. Thus, the ferrite-martensite microstructure minimizes continuous paths and resulting galvanic coupling and produces a steel that is highly corrosion resistant.

A specimen of the new MMFX steel reinforcing bar has been tested in an aggressive corrosive environment along with a conventional reinforcing bar that conformed to the requirements of American Society of Testing Materials (ASTM) Designation A 615, Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement. After 60 weeks of accelerated exposure in a highly saline solution, the MMFX bar did not show any measurable corrosion while the ASTM A 615 bar had significant damage. Similarly, specimens of each type of steel were cast in concrete and tested after 12 months of exposure. The MMFX bar exhibited negligible loss of mass while the ASTM A 615 bar did show some loss of mass in the relatively short testing period.

In addition to the corrosion resistance characteristics, the newly developed steel exceeds standard carbon steel in the material properties of strength, ductility, toughness (energy absorption), fatigue resistance, and brittleness. The MMFX steel is 25 percent stronger, is 200 percent more ductile, has approximately 300 percent higher energy absorption capabilities, has approximately 100 percent more fatigue resistance, and retains its strength at temperatures approximately 100°C colder than standard carbon steel. Additionally, the MMFX steel reinforcing bars meet or exceed the requirements of ASTM A 615. The new steel was developed to economically provide these superior characteristics and material properties and does not significantly exceed the cost of standard carbon steel.

MMFX Steel Company of America plans to begin production of the new steels in late 2000. With the California Department of Transportation being committed to using the new concrete reinforcing steel as soon as production meets their demands, the new steels will be placed in service and performance records will be initiated.

Please direct any questions or comments to Keith Christiansen, National Science and Technology Center, Division of Architecture and Engineering, at (303) 987-6853.

Signed by:
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